



STARTER MANUAL

OPERATOR'S GUIDE/INSTRUCTION MANUAL

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STARTER MANUAL

OPERATOR'S GUIDE AND INSTRUCTION MANUAL

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Information Provided By:



IMPORTANT

The information contained herein is not intended as a training manual for unqualified personnel. It does not relieve the user of responsibility to use sound practices in application, installation, operation, and maintenance of the equipment purchased or in personnel safety precautions. Should a conflict arise between the general information contained in this publication and the contents of drawings or supplementary information supplied with this equipment, the latter shall take precedence. RAM Industries reserves the right to make changes in specifications shown herein or add improvements at any time without notice or obligation.

WARNING

**DISCONNECT ALL SOURCES OF POWER AND
LOCKOUT BEFORE SERVICING THIS EQUIPMENT**

This equipment should be installed and maintained by qualified personnel only, in accordance with recognized safety standards and applicable electrical or building codes. The manufacturer is not responsible for damages or injuries resulting from improper installation or use.

For the purposes of this manual, a qualified person is one who is familiar with the installation, construction, or operation of the equipment and the hazards involved. In addition, he has the following qualifications:

- a) Is trained and authorized to energize, de-energize, clear, ground, and tag circuits and equipment in accordance with established safety practices.
- b) Is trained in the proper care and use of protective equipment such as rubber gloves, hard hat, safety glasses or face shields, flash clothing, etc., in accordance with established safety practices.
- c) Is trained and authorized to work on exposed parts that may be energized. d) Is trained in rendering first aid.
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RECEIVING, HANDLING, AND STORAGE

RECEIVING

- Industrial control equipment normally includes instrumentation, contactors, relays, and other similar devices which may be damaged if roughly handled.
- Inspect all equipment for shipping damage as soon as possible after receipt. Any signs of damage to the shipping container or wrapper may indicate that hidden damage has occurred. Notify your freight carrier immediately if any damage is apparent.

HANDLING

- This equipment may be unbalanced or top heavy. Adequately strap or brace all equipment prior to moving.
- Do not Top-Stack this equipment or lay on side. This may cause internal component shifting and damage.
- Any skids, crating, or other wrapping material

should be left on equipment until final installation whenever possible.

- Packaged equipment should be moved by fork-lift, balancing the load and using safety straps.
- Toplifting is not recommended unless suitable lifting eyes or angles have been provided. Under no circumstances should equipment be lifted by means of any panel mounted devices.

STORAGE

- Any equipment which is to be stored prior to its installation, should be checked before being placed in storage for possible damage during transit. It should then be repacked and stored in a location which is clean, dry, and has a uniform temperature to prevent condensation.
- When storage will be in or near buildings under construction, covers should be provided to protect against dust, moisture, and falling objects.

INSTALLATION

- **Location** - Unless specifically designed for unusual service conditions, this equipment should not be installed in a location where it will be exposed to ambient temperatures above 40C. (104.F), corrosive or explosive fumes, dust, vapors, dripping or standing water, abnormal vibration, shock, or at elevations above sea level greater than 2000m. (6600 ft.).
- All equipment should be located in-sight of, and/or as close to the motor as possible, in order to reduce requirements for additional disconnects and to reduce possible line losses.
- Floor mounted cabinets should be securely mounted to a clear level base using the mounting holes provided. Shim base of controller, if required, to prevent racking or possible misalignment of doors.
- Wall mounted cabinets should be securely mounted

to a flat, vertical surface or framework using the mounting holes provided, and be sufficient for the weight involved. Shim the rear of controller, if required, to prevent possible racking and misalignment of doors.

- Wiring - Install all conduits and wiring in a professional manner in compliance with the National Electrical Code (NFPA 70).
- A suitable disconnecting means and short circuit protection must be installed ahead of this equipment unless provided as part of the controller.
- The nameplate ratings of the equipment must agree with the power supply and the rating of the load. Unless otherwise specified, this equipment is designed for use with Copper conductors, rated 75C minimum.

START-UP

DANGER

Hazard of burn or electrical shock. Make certain that all incoming sources of power have been disconnected and tagged prior to working on this equipment

- Size all conductors in accordance with the National Electrical Code and loads as shown on applicable drawings. Minimum recommended wire sizes for control voltages are 14ga.AWG for 115V AC or 12ga.AWG at line voltage.
 - Assure that the correct field conductors are routed through any current monitors (if provided) prior to connecting to the proper load terminals. Tighten all connections to the proper torque values, as listed on equipment labels.
 - Remove all remaining packing and blocking material, and all debris from installation from inside controller.
 - With all power removed, manually exercise all circuit breakers, contactors, and relays to assure they are working freely. Pneumatic timers should be tested for proper time delay as shown on the drawings. Mechanical interlocks, if provided, should prevent one contactor from closing if the other is held in the energized state.
 - Check all conductors for signs of abrasion caused during installation, and verify that adequate spacing is maintained to ground and phase to phase, and that wiring is in accordance with the diagrams as provided. Test all wiring for freedom from short circuits and/or grounds. Re-tighten all internal and field connections to proper torque values. Replace any arc chutes, insulators, or phase barriers that may have been removed during installation.
 - Assure that all fuses are installed correctly and sized in accordance with the National Electric Code and drawings as provided. Check the trip settings of all circuit breakers and electronic overloads and set in accordance with diagrams. Ensure that any bimetallic or eutectic overloads are sized correctly and properly installed.
- Assure proper operation and sequencing of electro-mechanical devices by cycling the controller with no load applied as follows:
 1. Tag and temporarily remove all motor load wires from controller load terminals.

NOTE: Controller with KL Motor Protection Module will not cycle without a connected load. Utilize the KL BYPASS DEVICE by removing ONLY the KL Relay Plug from the KL Motor Protection Module and connecting it to Bypass Jack (J1). This will connect the Bypass Overload Relay (OLI) and Alternate Timer (CR1).

CAUTION! Do not operate the controller with any plugs other than the KL Relay Plug removed from the KL device.

2. Close main circuit breaker in controller to apply rated line voltage.
3. Observe operation and sequencing of controller relays and contactors.
4. If manual trip features are provided on overload relays or circuit breakers, these should be tested for proper operation.
5. After confirming proper operation, open main circuit breaker in controller to disconnect line voltage. Reconnect the KL relay plug to the KL Module. Reconnect motor load wires to controller.
6. Close door. Unit may now be energized and checked for correct motor rotation.

NOTE: Solid State Starters CANNOT be tested using the above procedure. Solid State Starters require a connected load.

TERMINAL & WIRE DATA

TABLE 1 – LINE TERMINALS FOR FVNR, RVAT, YD, AND SOLID STATE
STANDARD LUGS

230V MAX HP	380V MAX HP	460V MAX HP	575V MAX HP	ABB BREAKER FRAME SIZE	TRIP AMPS	WIRE RANGE	RAM P/N	MFG P/N
30	50	60	75	S3	150/225	(1) #2–4/0 AWG	CB-0292	K4TC
50	75	100	125	S3	150/225	(1) #4 AWG–300 KCMIL	CB-0293	K4TD
75	129	154	175	S4	250	(1) #4 AWG–300 KCMIL	CB-0293	K4TD
100	172	235	250	S5	400	(2) 3/0 AWG–250 KCMIL	CB-0296	K5TG
154	250	305	350	S6	600	(2) 250–500 KCMIL	CB-0297	K6TH
206	365	437	529	S6	600	(3) 2/0 AWG–400 KCMIL	CB-0298	K6TJ
300	450	600	700	S6	800	(3) 2/0 AWG–400 KCMIL	CB-0298	K6TJ
335	572	687	800	S7	1200	(4) 4/0 AWG–500 KCMIL	CB-0299	K7TK
CF	CF	CF	CF	—	—	—	—	—

AVAILABLE LUGS

ABB BREAKER FRAME SIZE	TRIP AMPS	WIRE RANGE	RAM P/N	MFG P/N
S3	150/225	(1) #14–2 AWG	CB-0290	K3TA
S3/S4	150/225	(1) #14–1/0 AWG	CB-0291	K4TB
S3/S4	150/225	(1) #2–4/0 AWG	CB-0292	K4TC
S3/S4	150/225	(1) #4 AWG–300 KCMIL	CB-0293	K4TD
S4	250	(1) #14–1/0 AWG	CB-0291	K4TB
S4	250	(1) #2–4/0 AWG	CB-0292	K4TC
S4	250	(1) #4 AWG–300 KCMIL	CB-0293	K4TD
S4	250	(1) #6 AWG–350 KCMIL	CB-0294	K4TE
S5	400	(1) 250–500 KCMIL	CB-0295	K5TF
S5	400	(2) 3/0 AWG–250 KCMIL	CB-0296	K5TG
S6	600/800	(2) 250–500 KCMIL	CB-0297	K6TH
S6	600/800	(3) 2/0 AWG–400 KCMIL	CB-0298	K6TJ
S7	1200	NO ALTERNATE	—	—

TABLE 2 – LOAD TERMINALS FOR FVNR, RVAT

STARTER SIZE BY HP		TERMINALS T1 - T2 - T3
230 VOLT	460 VOLT	
10 – 30	25 – 60	#8 – 1 AWG
40	75	#6 AWG – 2/0 KCMIL
50 – 60	100 – 125	#6 AWG – 250 KCMIL
75 – 100	150 – 200	#4 AWG – 400 KCMIL
125 – 150	250 – 350	(2) #4 AWG – 500 KCMIL
200 – 250	400 – 500	(2) #2/0 AWG – 500 KCMIL
300	600	(3) #2/0 AWG – 500 KCMIL

TABLE 3 – LOAD TERMINALS FOR FVNR, RVAT

STARTER SIZE BY HP		TERMINALS T1 - T2 - T3 T6 - T4 - T5
230 VOLT	460 VOLT	
10 – 30	25 – 30	#8 – 1 AWG
20 – 50	40 – 100	#8 – 1 AWG
60	125	#6 – 2/0 AWG
75 – 100	134 – 206	#6 AWG – 250 KCMIL
125 – 200	235 – 407	#4 AWG – 400 KCMIL
250 – 300	437 – 643	(2) #2/0 AWG – 500 KCMIL
350 – 450	687 – 900	(3) #2/0 AWG – 500 KCMIL

Notes:

- Tables show range of cable size possible. Consult NEC and local codes for proper cable sizing. Use copper wire only. Temp. rating 75°C minimum.

TABLE 4 – LOAD TERMINALS FOR SOLID STATE

STARTER SIZE BY HP		CHASSIS SIZE	TERMINALS T1 - T2 - T3
230 VOLT	460 VOLT		
15 – 25	25 – 50	CSS	#8 – 1 AWG
30 – 60	60 – 125	B1– B3	#6 – 250 AWG
75	150	C1	#4 AWG – 400 KCMIL
100	200 – 250	C2 – C3	(2) #4 AWG – 500 KCMIL
125 – 200	350 – 400	D1 – D3	(2) #2/0 AWG – 500 KCMIL
250	437 – 500	E1	(2) #2/0 AWG – 500 KCMIL
300	529 – 600	E2	(3) #2/0 AWG – 500 KCMIL

TABLE 5 – RECOMMENDED TIGHTENING TORQUE

Unless Otherwise Noted on Individual Device

WIRE SIZE	TORQUE - in/lb	
	SLOTTED HEAD SCREWS	HEX OR SOCKET HEAD SCREWS
#18 – #14 AWG	12	70
#12 – #8 AWG	20	70
#6 – #4 AWG	35	135
#2 – 2/0 AWG	50	165
3/0 – 4/0 AWG	—	225
250 – 400 KCMIL	—	295
500 – 750 KCMIL	—	340

MAINTENANCE

WARNING

Disconnect all incoming power to this equipment and lock-out and tag circuits prior to performing preventive maintenance. Discharge capacitors, if present. Positively ascertain that the equipment is totally de-energized, including possible foreign sources by using appropriate metering.

- For equipment to operate properly, and to reduce unscheduled down-time, a periodic maintenance program should be established. NFPA Publication 70B (Electrical Equipment Maintenance) may be used as a guide.
- It is recommended that at least once each year the following steps be taken.

ENCLOSURES

- Carefully inspect all enclosure surfaces for signs of excessive heat. As a general rule of thumb, any temperature which the palm of the hand cannot stand for about 3 seconds may indicate a problem.
- Check all cabinet doors to assure proper operation and that all door latching and/or locking devices are in proper working order.
- Remove all cabinet filters, if supplied, clean as required, and replace.
- Look inside cabinets for any signs of moisture, dripping, or condensation. Seal off any conduits which may have dripped condensate or provide an alternate means for drainage. Seal off any cracks or openings which may have allowed moisture to enter the enclosure and eliminate the source of moisture on the outside of the enclosure.
- Thoroughly dry all cabinet surfaces and any insulating material which may be damp or wet. If accumulated deposits are apparent, conduct an electrical insulation test to assure proper insulation integrity.
- If there is an accumulation of dust, remove with a vacuum cleaner or clean with lint-free rags. Do not attempt to use compressed air as it may contaminate other internal components.

WIRING

- Inspect all accessible wiring for signs of looseness or overheating. Re-tighten to proper torque values as required. If major discoloration of wire insulation or cable damage is apparent, replace the affected cable.
- Identify and re-mark all cables in accordance with equipment drawings where required.

DISCONNECTING MEANS

- Inspect all terminations for signs of looseness or overheating. Re-tighten to proper torque values as required.
- Operate each device manually to assure proper operation and test manual trip feature, if equipped. Check for proper trip settings and adjust if required. Assure that any insulators or arc barriers are intact and in place.

FUSES

- Examine all fuse clips and fuse blocks for signs of overheating or looseness. If there is any indication of reduced spring tension or overheating, replace the fuse clips or fuse block assembly.
- Assure that all fuses are the correct type and the proper size as listed on devices and applicable drawings.

CONTACTORS AND RELAYS

- If there is an accumulation of dust, remove with a vacuum cleaner or clean with lint-free rags. Do not attempt to use compressed air as it may contaminate other internal components.
- Check all component terminals for signs of looseness or overheating and re-torque to proper values as required. If terminal is badly discolored, it may indicate that a high resistance joint or contact exists. Remove the arc chutes on the device to inspect contact condition.
- Inspect all accessible devices for breakage, cracks, or signs of sooty deposits, spattering, or carbon tracking. Clean all affected surfaces and replace damaged or cracked components.
- Inspect contact condition for signs of excessive heating, uneven wear, or unequal spring tension. Indications of light sooty deposits, minor pitting, or material displacement do not indicate a problem if all surfaces are worn equally. Do not attempt to file or dress contact surfaces with abrasives, as this will likely increase the wear rate of the contacts.
- Manually operate all power contactors and check wear indicators, if equipped. If wear indicators

show 50% or less remaining life, or if contact surfaces indicate excessive or uneven wear, all contacts and spring carriers should be replaced.

- Assure that all contact screws are tightened and all barriers and arc chutes are replaced.

OVERLOADS

- Check all terminations for looseness or overheating and re-torque to proper values.
- Assure that all devices settings are in accordance with drawings and correct for the applied load.
- Test all overloads by using the manual trip feature, if so equipped.

GENERAL

- If equipment is supplied with internal or external cooling fans, test to assure proper operation.
- List all component part numbers which may be showing signs of wear, and order replacements for installation at next scheduled shut-down period.
- Note any equipment additions and/or wiring modifications on the appropriate drawings, for maintenance use and trouble-shooting.

MAINTENANCE AFTER A FAULT HAS OCCURRED

After a fault has occurred, all equipment must be de-energized, disconnected, and isolated to prevent accidental contact with live parts. Check voltage on all terminals before touching or working on equipment. Only qualified individuals should be involved in the inspection and repair procedures and all safety precautions must be observed.

- The excessive currents occurring during a fault may result in enclosure, component, and/or conductor damage due to mechanical distortion, thermal damage, metal deposits, or smoke. After a fault, determine the cause, inspect, and make any necessary repairs or replacements prior to re-commissioning this equipment. The following procedure is recommended for this inspection.

ENCLOSURE

- Check cabinet exterior for any signs of deformation or heat damage. Assure that all hinges and cabinet latching and/or locking mechanisms are in working order. Replace affected parts if required.

DISCONNECTING MEANS

- The external disconnect operator must be capable of opening the circuit breaker or switch. Inspect all door interlocks for proper function. Replace operator mechanism, door interlock, and related parts that show signs of binding, warping, or abnormal wear.
- Inspect circuit breakers for any signs of damage or deterioration. If it is suspected that the circuit breaker has opened several short circuits, it should be replaced.
- Inspect disconnect switches for any signs of overheating, blade wear or welding, or broken or missing insulators. Replace any damaged insulators or arc chutes.
- After replacing damaged components, operate disconnect device several times to assure all mechanisms work properly.

FUSES

- Always replace all three fuses in a three phase circuit, even though only one or two are open. Possible heat damage in the remaining fuse(s) could result in a shutdown later.

TERMINALS AND INTERNAL CONDUCTORS

- Replace all damaged parts which show signs of discoloration, melting, or arcing damage.

CONTACTORS AND RELAYS

- Replace all contacts and contact springs if inspection shows signs of welding, displacement of metal, heat damage, or excessive wear. If device shows any signs of binding, or arcing and flash damage, replace the entire component. Perform an insulation resistance test to verify insulation integrity.

OVERLOADS

- Visually inspect all overload devices for signs of arcing or other heat damage. If there is any sign of arcing or burning on the overload, or if burnout of the heater element has occurred, the entire overload device must be replaced.

RESTORING TO SERVICE

- Before restoring the equipment to service, it is recommended that the steps outlined in procedures for STARTUP are followed.

Application Guidelines

STARTER TYPE	STARTING CHARACTERISTICS IN PERCENT OF FULL VOLTAGE VALUES				TRANSITION	EXTRA ACCELER. STEPS AVAILABLE	COST OF INSTALLATION	ADVANTAGES	DISADVANTAGES	REMARKS	APPLICATIONS
	VOLTAGE AT MOTOR	LINE CURRENT	STARTING TORQUE	STANDARD MOTOR							
ACROSS THE LINE	100%	100%	100%	YES	NONE	NONE	LOWEST	<ul style="list-style-type: none"> • INEXPENSIVE • READILY AVAILABLE • SIMPLE TO MAINTAIN 	<ul style="list-style-type: none"> • HIGH INRUSH • HIGH STARTING TORQUE 		<ul style="list-style-type: none"> • MANY AND VARIOUS
AUTO TRANSFORMER	80% 65% 50%	64% 42% 25%	64% 42% 25%	YES	CLOSED	NO	HIGH	<ul style="list-style-type: none"> • HIGH TORQUE PER LINE CURRENT • ADJUSTABLE TAPS FOR TORQUE • SUITABLE FOR RELATIVELY LONG ACCELERATION • MOTOR AMPS ARE GREATER THAN LINE AMPS 	<ul style="list-style-type: none"> • LOW POWER FACTOR • LARGE PHYSICAL SIZE • MOST EXPENSIVE IN LOWER HP RATINGS 	<ul style="list-style-type: none"> • VERY EFFICIENT • FLEXIBLE THRU TAP CHANGES 	<ul style="list-style-type: none"> • BLOWERS • PUMPS • COMPRESSORS • CONVEYORS
PART WINDING	100%	65%	48%	ONLY ON 230V	CLOSED	YES (BUT NOT COMMON)	LOW	<ul style="list-style-type: none"> • LEAST COSTLY METHOD • SMALL SIZE 	<ul style="list-style-type: none"> • NOT SUITED FOR LONG ACCELERATING LOADS • REQUIRES A SPECIAL MOTOR FOR 460V INERTIA LOADS • NOT RECOMMENDED FOR 3600 RPM MOTORS 	<ul style="list-style-type: none"> • ACTUALLY NOT A REDUCED VOLTAGE STARTER, BUT AN INCREMENTAL TYPE CONTROL 	<ul style="list-style-type: none"> • RECIPROCATING COMPRESSORS • PUMPS • FANS
WYE DELTA OPEN <small>NOT RECOMMENDED</small>	100%	33%	33%	NO	OPEN	NO	MEDIUM	<ul style="list-style-type: none"> • SUITABLE FOR HIGH INERTIA LONG ACCELERATING LOADS • IDEAL FOR FREQUENT STARTING • IDEAL FOR STRINGENT UTILITY REQUIREMENTS 	<ul style="list-style-type: none"> • REQUIRES A SPECIAL MOTOR • LOW STARTING TORQUE • (OPEN TRANSITION TYPE ONLY) DISCONNECTION OF MOTOR FROM LINE, DURING TRANSITION, MAY CAUSE HIGH TRANSIENT CURRENTS, REDUCING MOTOR INSULATION LIFE AND ALSO NUISANCE TRIPS OF CIRCUIT BREAKERS 	<ul style="list-style-type: none"> • ACTUALLY AN INCREMENTAL TYPE STARTER • VERY EFFICIENT 	<ul style="list-style-type: none"> • CENTRIFUGAL COMPRESSORS • CENTRIFUGES
WYE DELTA CLOSED	100%	33%	33%	NO	CLOSED	NO	MEDIUM				
SOLID STATE	0-100%	25-100%	10-100%	YES	NONE	STEPLESS	MEDIUM TO HIGH	<ul style="list-style-type: none"> • SUITABLE FOR LONG ACCELERATION • STEPLESS TRANSITION • HIGHEST ADJUSTABILITY • NO MOVING PARTS 	<ul style="list-style-type: none"> • MAY CAUSE TORQUE CUSP PROBLEMS WITH SOME MOTORS • VOLTAGE DROP ACROSS SCRs MAY CAUSE HEAT PROBLEMS IN SOME APPLICATIONS • IF MIS-ADJUSTED, MAY CAUSE MOTOR STALLING OR FAILURE TO ACCELERATE • LOW ABILITY TO WITHSTAND BOLTED FAULT CONDITIONS 	<ul style="list-style-type: none"> • TEMPERATURE SENSITIVE • REQUIRES SET-UP ON SITE 	<ul style="list-style-type: none"> • MANY AND VARIOUS

NOTES

